PEST TECHNOLOGY
Pest Control and Pesticides

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What's in a Name ?

"YEARS AGO there were fertilisers and there were pesticides. The two kinds of materials were quite different and there was no confusion between them. Now, there are mixtures of fertilisers with pesticides. There are fertilisers with some incidental pesticidal values as well as pesticides with some incidental fertiliser values. There are materials that simultaneously act as fertilisers as well as pesticides. There are materials that are used in certain ways on certain crops as fertilisers and used in other ways on other crops as pesticides.

"To complicate the problem, a number of new chemicals have been developed to affect soils, plants and crops in ways undreamed of in earlier years. The concepts of what constitutes a fertiliser and what constitutes a pesticide have expanded with the developments in agricultural chemistry since the war. The two fields have grown together and overlapped to such an extent that it is sometimes difficult to classify some of the new products that appear on the scene."

These words are not those of the writer but of Robert Z. Rollins, of the Bureau of Chemistry, State Department of Agriculture, California.

Mr. Rollins does not attempt to provide an answer to the question he poses in his title. He only attempts to document the confusion which exists in the United States, especially acute because of the absence of any federal law on the subject, apparently.

He indicates that many of the agricultural chemicals that are appearing on the market, and that will appear in the coming years, are in the "twilight zone" between simple nutrients like NPK and simple pesticides like DDT.

One wonders, however, whether there is not a pointer here to a re-examination of the nomenclature not only at global level which can only be done presumably through the medium of international conference and exchange and goodwill, but also in our own country.

Are we satisfied with our own position? Is the nomenclature adequate for a developing industry? Is there not scope for improvement? From discussions the writer has had more than one prominent member of the Industry, seemingly, is far from satisfied with the prevailing position.

NEW YEAR MESSAGE

from H. G. HUCKLE

Chairman, Association of British Manufacturers of Agricultural Chemicals.

WE AS MANUFACTURERS of agricultural chemicals can, I think, look back on 1958 as a year which has seen further progress in the use of chemicals on the land. I am not only thinking of the word progress in its commercial sense; we must surely take a wider view. If the farmer continues to make use of the technical advances which are offered to him, the national production of crops and food must continue to rise. The very close co-operation which we in the industry maintain with the Ministry of Agriculture is evidence that this is the view taken by the Government.

Great strides have been made during the last few years in the development of organic herbicides, insecticides and fungicides and today the use of chemicals for crop protection purposes forms an integral part of British agricultural practice. Apart from the impact of chemical developments on British agriculture, the production of pesticides has now become a substantial and vigorous section of the chemical industry in this country, and with research proceeding actively there appear to be excellent prospects for further expansion in the immediate future.

In the weedkiller field selective herbicides are playing an increasing part for application to such crops as sugar beet, turnips, kale, vegetable crops and fruit. More effective and safe grass weedkillers which may be used selectively in growing crops are required, and there are certain important and specific problems, such as chemical control of bracken. In other words, we as an industry are constantly presented with new problems which are a challenge to our research workers. It is a challenge which we feel competent to meet stage by stage.

Any New Year message cannot ignore this country's trading links with the rest of the world. More specifically, I would refer to the current difficulties which have arisen in establishing a European Free Trade Area. It seems to me that the agreement that has now become operative for the six countries of European Common Market underlines the necessity for reaching an agreement in the wider European Free Trade Area (which includes Britain and ten other West European nations). I think that we as manufacturers of agricultural chemicals would welcome tangible results on this question to which the Government attaches so much importance.

I should like to extend a welcome to your new journal and the very best wishes of this Association for your endeavours in 1959.

NEW YEAR MESSAGE

from A. FRASER McINTOSH

President, Industrial Pest Control Association.

THE INDUSTRIAL PEST CONTROL ASSOCIATION is delighted to send greetings to the readers of *Pest Technology*, in this, the first New Year of its publication. The Association welcomes the Journal which it feels, fills the long felt need in the specialised branch of science generally known as pest control, and wishes it every success in the future. The Association, whose members are specialised in industrial pest technology, looks forward with confidence to 1959. The members feel there is a growing appreciation both among the authorities and the general public on the need for higher standards for industrial and food hygiene and are ready to play their part in the attainment of these higher standards.

The Industrial Pest Control Association, since its formation in 1942 has stressed as one of its main objects, the maintenance of a high technical standard for the products, methods and appliances used in the control of industrial pests. The acceptance and compliance with the Association Standards is one of the conditions of membership.

During 1959 the Association may well be called upon to consider problems which are likely to arise if a European Free Trade Area is created. Already agreement has been reached within the Association on the difficult question of definition of origin of pesticides which should move ultimately without duty in the Free Trade Area. Other problems such as the unification of regulations concerning pesticides may well loom to the fore. The Association is ready and willing to take an active part in discussions concerning these or other problems of an international nature.

Woodworm Extermination

THE MODERN APPROACH TO HOME PROTECTION

Some Notes on the Progress and Activities of Rentokil Limited

By N. E. HICKIN, Ph.D., B.Sc., F.R.E.S., F.Z.S.

FOR WELL OVER thirty years Rentokil Limited have been in the forefront in the development of products and equipment for treatment of timber infested with wood-boring insects. It can be said that the first formulation of Rentokil was indeed the first modern formulation of scientifically balanced chemicals for such a purpose and was used for treating some of the beams in Westminster Hall against Death Watch beetle. In 1945 Rentokil by including the, then, new substance DDT into the formula, brought about a revolution in wood preservative formulae.

More recently March 1958 (just a year after joining the British Ratin Group) saw another big stride forward by the production of the first efficient one-coat fluid for destroying wood-boring insects. This was accomplished, not only by increasing the level to which modern contact insecticides could be incorporated, but brought about in the main, also, by a very large increase in the speed of penetration of the fluid into wood.

On the scientific side, the first observations recorded in scientific journals concerning the very great increase in furniture beetle *Anobium punctatum* came from the Rentokil laboratories and a tradition of knowledge of the biology of Furniture Beetle, Lyctus, Death Watch, House Longhorn and many other species has been built up and maintained in the Leatherhead laboratory. Much information of scientific interest has been made freely available to the wood preservation industry and many Timber Infestation Surveyors and other personnel intimately connected with wood decay have received their training at Rentokil.

Rentokil

One of the best-known brand names over many years for products for exterminating woodworm has been Rentokil Timber Fluid, and with the very great increase in woodworm infestation that has taken place in the post-war years, its name has become a household word; but the public have known the product as " Rentokil " and in March 1958 the Company decided to fall in with public usage and also call the product " Rentokil " (and at the same time doing away with the words " Timber Fluid ") so that the name Rentokil is retained only for the woodworm exterminator.

March 1958 was also the date for the new packaging design to be launched. Not only for the product Rentokil but other products in the same group. In addition, the substantial increase in woodworm-killing efficiency has already been mentioned. The speed of penetration into unpolished woodwork is most surprising. The wood appearing to absorb the fluid, just as a sponge, and it is this speed of penetration which has enabled the company to increase the insecticidal efficiency. All Rentokil products are characterised by the House Symbol, which consists of three hexagons—black, red and white and the inclusion of this symbol to a greater or a lesser size together with other devices, gives a strong family resemblance to all products in the group.

Rentopol

March 1958, was also the date for launching the new Rentopol Silicone Furniture Cream and the Rentopol Silicone Wax on the market. These polishes stand in their own right as polishes, but in addition, modern contact insecticides are incorporated which give protection against woodworm. Only the highest quality waxes are used and Carnauba is included on account of its hardness which gives the " non-fingering " property. Quite apart from the woodworm protection efficiency, Rentopol Wax and Cream have a very decided value not only in the home, but in hospital and commercial premises, on account of their fly and other insect-killing properties.

Rentodye

Rentodye is another product in the group. This is a wood stain in nine colours as follows: Maple, Medium Walnut, Light Oak, Medium Oak, Dark Oak, Black Oak, Medium Mahogany, Dark Mahogany with also a clear version which can be used for modifying any of the previous colours. These wood dyes can be used by the amateur craftsman who builds up furniture from the well-known kits and the professional furniture manufacturer. Rentodye also plays a dual role as woodworm-killing insecticides are incorporated into the formula along with the colouring dyes. With the general extermination of Woodworm into all mature softwoods (over twenty years old!) Rentodyes give a particularly important service in staining floors and floor surrounds.

Injectors

No account of the activities of Rentokil Limited would be complete without allusion to the Rentokil Junior Injector. This has become almost part of the household equipment and if there is anyone still left who doubts that woodworm is now of national importance as a pest, he should know that sometime in the early spring of 1959, over a million of these injectors will have been sold in the United Kingdom alone. Two British Patents are current in connection with their manufacture and the inclusion of the House Symbol as a transfer on the plastic container gives the Junior Injector a very pleasing appearance. The larger injector known as " The Fetcham " has undergone a considerable change in design and is now a dual-purpose injector and sprayer, this is invaluable to the builder and even to the householder as it can also be used as a garden spray.

Aerosols

Three aerosols are to be marketed in 1959 as follows: Rentofab, which is the Rentokil Mothproofer in aerosol form, in addition Rentokil Mothproofer is available in larger sizes for household, warehouse and industrial use. Rentofly is specifically formulated as a fly exterminator, with a good knock-down and a heavy residual effect. Rentofresh, a germicidal air freshener is the third member of the aerosol trio. This aerosol will deal with obnoxious and stale smells and will help very materially to prevent the spread of air-borne infection. A reduction in price to 4/11d. for each aerosol has been announced.

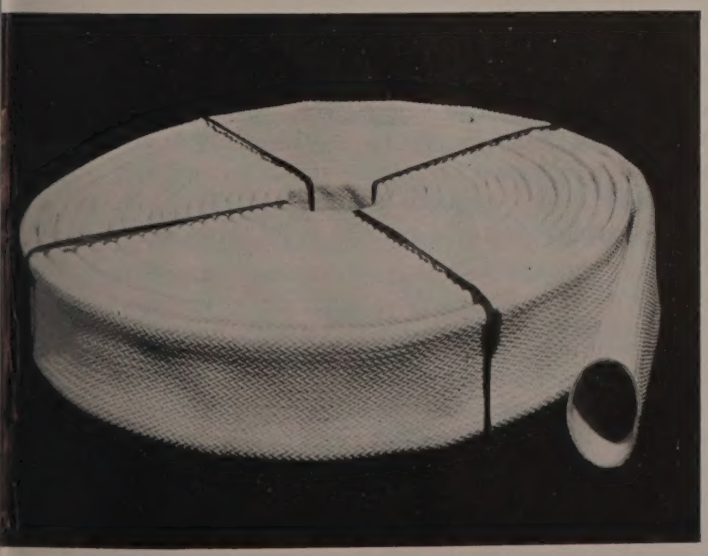
This might be the appropriate place to mention that a lecture was recently given in the Woodworm and Dry Rot Centre, 23 Bedford Square, London, in order to inform all the suppliers of Rentokil Limited, that is, the chemical manufacturers, paper, printing, cartons, transport, containers and many other manufacturers of products and suppliers of services, to acquaint them with the new range of products and packaging and to bring them all into the picture. And perhaps this is also the place to thank all these same people, very much indeed for their help and their co-operation and advice—all so very necessary in a major packaging change operation.

Note on Author

Dr. Norman E. Hickin is, of course, well known as an Entomologist. He has been Technical Director of Rentokil Limited for over 10 years and has played a substantial part in building both Rentokil Limited and Woodworm & Dry Rot Control Limited.

He is a Member of Council and Treasurer of the Royal Entomological Society—a Member of Council of the Institute of Biology—he sits on the Parliamentary Scientific and Advisory Committee—is a member of the Executive Council of the newly formed "Council for Nature"—is a member of the Biological Council—the author of many papers of entomological interest—the author of two books, i.e. "Caddis" and "Woodworm —Its biology and extermination"—takes a keen, active interest in the biological problems of East Africa—is a photographer of big game. He is also a leading authority and lecturer on Woodworm—Dry Rot—Moths.

Fumigation canopy of proofed nylon fabric



Plastidry hose coiled flat

New Fibres to the Rescue

NEW FIBRES are being used increasingly in man's age-old fight against pests. For instance, nylon and Terylene are two fibres which are finding an outlet for light, high-strength hose, of patented construction and known as plastidry. Plastidry is light, flexible and rotproof and particularly valuable for use in tropical climates where constant delivery of water for irrigation purposes is a vital necessity. It may also be used for carrying drinking water as it imparts no odour or taste —or for carrying fertilising and crop-spraying fluids.

Plastidry, by reason of its portability, is especially useful for irrigation work where the sprinkler or spray gun has to be moved from place to place. It cuts out costly labour—large lengths up to 150 ft. can be carried by one man and will circumnavigate difficult obstacles. It has none of the disadvantages of conventional hose—it may be left lying wet in the open, in any climate, without deterioration. Tests have proved that plastidry resists the damaging effects of ultra-violet rays, present in strong sunlight, and can withstand attacks of insects, rodents and fungi. This extremely flexible and light-weight hose consists of a PVC cover and lining fused on to a nylon, Terylene, or nylon/Terylene reinforcing fabric to form a plastic mass of pronounced strength and wear resistance. It may be used in any climate.

Coil flat hose of this construction is also being used for carrying flour-grain or cement and in addition a wide range of beverages from milk to beer.

Nylon fabrics proofed with either PVC or Neoprene are being used very successfully as fumigation canopies for the disinfestation of harvested crops such as ground nuts in Nigeria and other parts of Africa. They can be given an aluminium finish to reflect the sun's heat. The total weight of the proofed nylon fabrics is around 10 to 12 oz./sq. yd. but although light in weight and easy to handle nylon's strength is so great that they are extremely tough and have a very high tear strength. The fabrics are impermeable and gas-tight, require little maintenance and have a long life. Similar proofed nylon fabrics are now being used in Britain for tarpaulins.

Occupational Hazards Arising From The Use Of Toxic Substances in Agriculture*

by J. M. BARNES, M.B., B.CHIR.

" So far as is known the toxic chemicals used in pest control, produce effects in man similar to those already shown in experimental animals."

THE INTRODUCTION during the past fifteen years of many new chemicals in the table for the control of important agricultural pests—insects, fungi and weeds—has focussed considerable attention on this particular subject. The fact that some of the chemicals used for this purpose are very toxic to man as well as to the pests explains this interest in the possible hazards that might accompany the introduction of such chemicals on the farm.

At the outset it is important to put the problem in its proper perspective. The number of deaths and the hours lost from work arising from " poisonous " substances amounts to less than 1 per cent. of the total among agricultural workers. The vast majority of accidents are caused by machinery and tractors, falls from ladders, and injuries from animals such as bulls.

The chemicals which are used in the largest quantities for pest control in this country are those of such low toxicity that they are quite safe to handle in ordinary agricultural usage. In the field, the use of chemicals for pest control is almost confined to the spring and summer months, although autumn infestations may sometimes occur and demand treatment, and toxic materials may be used as haulm destroyers before the potato harvest. The application of these pest-control chemicals may be done by the farmer and his employees in many instances, but there are organizations which offer a contract service for spraying crops and fruit trees. Insecticides and fungicides are often applied to seed before sowing; this is now done almost exclusively by merchants with proper machinery rather than by individual farmers.

Whilst inexperience in handling dangerous materials may increase the hazard to individual users, it is usual for them to handle a toxic material for only a few days in the season. The contract sprayers will employ trained crews with efficient equipment, but exposure of their employees to a particular substance will usually be more prolonged.

How dangerous exposure occurs

It is universal experience with these toxic materials that the greatest exposure occurs among those who handle the concentrates. These concentrates may be diluted a hundred times or more with water before the final solution is ready to apply to the crop, so that splashes which occur when opening or pouring from the original containers are many times more dangerous than those from the solutions actually sprayed. Responsible men capable of being trained must be employed for this work but, as pest infestations may build up rapidly in different areas at the same time, there is often a reason for hurrying, and long hours may be worked during the summer days. Special equipment is usually needed to ensure the correct application of the materials to the crops and this must be cleaned properly to ensure good performance. The temptation for a man in a hurry to clear a blocked jet by blowing down it may be hard to resist.

Because many of the materials are put up as fine sprays in order to get good coverage of the crops, there has been a tendency to regard inhalation of the materials as the most serious hazard. Careful American work has shown, however, that under practical conditions in orchards the greatest exposure to the chemicals sprayed arises from contamination of the skin (Batchelor and Walker, 1954; Batchelor, Walker and Elliott, 1956). In open fields, inhalation hazards are almost certainly less than in the quiet atmosphere of an orchard. They will, however, present a special problem in the closed glasshouse.

Control of Hazards

The most important part of any control of hazards is that which ensures that a man handling a toxic material is aware of its dangers, and able to appreciate the significance of a warning. At the same time he must be given facilities which will enable him to observe whatever safety precautions are recommended. The adequate labelling of the original containers of all reputable products is ensured by the voluntary cooperation of the

industrial associations. The most poisonous materials must comply with the Poison Rules, which ensure that adequate warnings of danger are included on the label. Although no manufacturer wishes to have accidents from the use or misuse of his product, his representative may not always spend much time explaining the possible dangers of the product he is hoping to sell in face of intense competition. Freedom from toxicity is, of course, a selling point for some products because there are also regulations which have to be observed when certain scheduled substances are used. As new chemicals are introduced they are considered by an interdepartmental advisory committee. This committee, on the basis of expert advice, will decide whether or not a new material shall be scheduled under the regulations of the Agriculture (Poisonous Substances) Act which was drawn up for the express purpose of protecting the worker who applies post-control chemicals.

The regulations specify the type of operation for which a material may be used and the nature of any protective clothing, gloves, overalls, boots, face-shields or respirators that must be worn. They also limit the age of the workers, and the number of hours worked, and compel an employer to keep records of the hours worked with scheduled substances. He must also provide facilities for the operator to follow the safety rules laid down for the application of the chemicals. A leaflet (APS11) issued by the Ministry of Agriculture explains the regulations and outlines the provisions of the Act as well as listing the materials at present scheduled.

To enforce the provisions of this Act inspectors are employed by the Ministry of Agriculture. The obvious difficulties of any sort of control by regulation enforced by inspectors means that ,in practice, voluntary discipline amongst users plays a most important part in preventing accidents, and the comparative freedom from severe cases of poisoning in recent years speaks well for the effectiveness of this type of control.

Another hazard arises from the handling of recently sprayed crops, as when fruit trees are pruned or stripped too soon after spraying. No such instances have been reported in this country. A few, all of which involved the use of parathion, have been reported from the United States (Quimby and Lemon, 1958).

Insecticides

NICOTINE, DDT AND BHC

Nicotine is still one of the most poisonous insecticides in use. Splashes of the concentrate can be dangerous, as it is rapidly absorbed through the skin.

DDT (*Dicophane*) *and BHC* (*benzene hexachloride;* '*lindane*') have been widely used for many years and no authentic cases of poisoning in man have been attributed to their use in agriculture; in other circumstances men have occasionally been poisoned by them. DDT causes symptoms apparently affecting the peripheral nervous system; BHC is a convulsive poison although its site of action within the central nervous system is not known.

DIELDRIN AND RELATED COMPOUNDS

Dieldrin, aldrin and endrin are related compounds with a toxic action on mammals which is similar to that of BHC. They have not been widely used in agriculture in this country although, because of its action against certain soil pests, aldrin is included in some commercial fertilizers. Dieldrin may be sprayed on growing crops and is used extensively as a dressing for cereal seeds. Although no cases of poisoning by endrin have occurred amongst agricultural workers in this country it has a relatively high toxicity to mammals and is included in the Regulations. In public health work elsewhere, dieldrin is used extensively and cases of poisoning have been reported (Patel and Rao, 1958). The conditions of use and intensity of exposure do not really compare with those arising in agriculture in this country. It is reassuring, however, to know that serious symptoms and signs of poisoning, such as epileptiform convulsions, may be followed by complete recovery. This has also been illustrated in cases of accidental poisoning by endrin following the contamination of flour in transit (Davies and Lewis, 1956). Unfortunately there seem to be no early warning signs of mild poisoning by this type of insecticide nor are there any clinical or biochemical tests which can indicate that absorption has taken place at levels below a toxic dose.

Animal experiments and limited clinical experience underline the value of barbiturates in therapy: both the long- and short-acting barbiturates will control convulsions.

ORGANO-PHOSPHORUS COMPOUNDS

The organo-phosphorus compounds form a big group of active insecticides. In their toxicity towards mammals they range from those with a lethal dose of 1 mg. to those not lethal at 1 g. per kg. body weight. Unfortunately the least toxic compounds will not always give adequate control of particular pests under practical conditions.

Parathion was one of the first to be developed, and is

the most toxic material in common use; it has been responsible for most of the accidents with organophosphorus insecticides. There has been no survey of the cases of parathion poisoning in this country but there have been no deaths and probably very few even suspected cases of poisoning. Summaries of cases have been published in the United States, Germany and Switzerland (Freeman and Epstein, 1955; Gassman, 1957; Pribilla, 1955). In Germany, deaths from parathion taken with suicidal intent outnumber accidental poisonings. A recent account of a single case of fatal parathion poisoning in Australia illustrates extremely well the folly of handling this substance carelessly and disregarding all the simplest rules of hygiene. The cumulative effect is also indicated by this case (Gilsenan, 1957). A new material, amiton, is slightly more toxic but its use is limited at the present time.

Ethyl pyrophosphate—TEPP is toxic but unstable and is not widely used, except when spraying of a crop such as lettuce is necessary just before harvest.

A new compound, '*phosdrin*,' also toxic and unstable, has been introduced in recent years for the similar quick clearance of insects so that no residue will remain in the plant a day or two later. " Phosdrin " is one of the group of systemic insecticides. These are materials taken up into the plant juices. Older ones are *schradan*, *demeton* and more recently *demeton methyl* and *rogor*. The two last-named are less toxic, and less stringent precautions are necessary in applying them. *Diazinon* is a contact insecticide of moderate toxicity. Not used extensively hitherto in this country, it has been widely used in Europe and included in domestic sprays for fly control. Finally, lowest on the scale of mammalian toxicity is *malathion*, which appears to be virtually harmless (Walters, 1957).

Toxic effects—These organo-phosphorus insecticides have one common bio-chemical action, namely the inhibition of the enzyme, cholinesterase. This enzyme by regulating the persistence of acetylcholine at vital points in the central and peripheral nervous system is of critical importance. The early symptoms of poisoning are all related to stimulation of the para-sympathetic nervous system and depend to some extent upon the chemical nature of the compound and the route of entry. Some compounds, such as TEPP or " phosdrin," are themselves inhibitors of cholinesterase. If splashed in the eye, or if droplets are inhaled, there is immediate contraction of the pupil or constriction of the airways. Others, like parathion or schradan, only become inhibitors of cholinesterase after they have been absorbed and oxidized in the liver. The oxidized products recirculate to attack cholinesterase in the different tissues. Thus, pupillary constriction is not a constant finding in parathion poisoning (Dixon, 1957). The need for a chemical transformation to take place before parathion exerts its effects may also account for the fact that signs of poisoning may appear after exposure has ceased. It is clear, however, that the amounts of enzyme normally present are far in excess of minimum requirements so that a considerably degree of inhibition can be produced before serious poisoning occurs. It is for this reason that tests for the activity of blood cholineterase are so useful in indicating that exposure has occurred before poisoning has become serious. Whilst the accurate determination of cholinesterase activity is a procedure requiring special skill and equipment, there are several simpler methods which can be carried out literally in the field (Edson, 1958). These are quite adequate to demonstrate an undesirable degree of inhibition of cholinesterase which, if discovered, would make it necessary to remove a man from further exposure and also to inquire into the circumstances which led to exposure taking place. Symptoms appear when about 60 to 80 per cent. of the normal cholinesterase activity has been destroyed. Salivation, nausea, colic, vomiting and diarrhœa result from stimulation of the alimentary tract. A slow pulse is the result of vagal stimulation. Muscular fasciculations, usually starting in the face but later spreading all over the body, result from inhibition of cholinesterase at the muscle-nerve junctions. This also leads to muscle weakness. Cyanosis may be a combined effect of circulatory and respiratory embarrassment, and loss of consciousness may indicate a superadded effect upon the central nervous system itself. Death is from respiratory failure.

Treatment for poisoning by organo-phosphorus compounds has long been based upon the repeated administration of atropine ($^1/_{50}$ grain [1.2 mg.]). Atropine counteracts the action of the excess of acetylcholine at some, but not all, important points; the muscle-nerve junctions are exceptions. Death is due to respiratory failure, and artificial respiration has successfully tided over a few victims until natural breathing was resumed. Natural recovery from poisoning takes place as a result of the removal of the inhibitor from the enzyme molecule by a process of hydrolysis. The speed with which this happens depends to some extent upon the chemical structure of the insecticide. In most cases it is a relatively slow process, hence the danger of cumulative poisoning if a man is repeatedly exposed to these compounds day after day. Progressive inhibition may take

place more rapidly than natural recovery of the enzyme activity. Recently, however, a group of compounds has been discovered which can greatly speed up the restoration of cholinesterase activity. Clinical experience with these compounds has been very limited except apparently in Japan. A recent report (Namba and Hiraki, 1958) indicates the enormous number of cases of parathion poisoning which have occurred in that country, but it has been found that the substance, 2-pyridine aldoxime methiodide, reverses severe signs of parathion poisoning rapidly and permanently, and is well tolerated.

Although the effects of the great majority of organophosphorus insecticides are transitory, one particular compound (mipafox), not now on the market, was accidentally found to possess the undesirable property of causing severe nerve lesions after an interval of about ten days (Bidstrup and Hunter, 1952). The syndrome is similar to the better-known effect of the (organophosphorus) compound—tricresyl phosphate (" ginger jake "). Fortunately, as a test animal, the chicken appears to be as sensitive as man to this peculiar property of a few of the organo-phosphorus compounds. All new organo-phosphorus compounds proposed for use as insecticides can be screened for this neurotoxic property by tests on hens. Those in common use do not have this action (Durham, Gaines and Hayes, 1956).

Fluoroacetate and the related fluoroacetamide are powerful systemic insecticides and a preparation containing fluoroacetamide (" tritox ") has recently been introduced. " Tritox " also contains acetamide which has some antidote action in fluoroacetamide poisoning.

Fungicides

There is a number of comparatively harmless fungicides which are used quite extensively: lime sulphur, copper compounds, captan and some dithio-carbamates. Among the most effective fungicides are the organo-mercury compounds. Phenyl mercury compounds are used extensively in some areas on fruit trees. Although the concentrated solutions of these salts will readily burn the skin, these particular mercury compounds are not considered to be very hazardous—probably because of their low volatility. The same type of compound is also used in many seed dressings. The alkyl mercury derivatives, e.g. ethyl mercury chloride, are said to be much better fungicides and some, because of their greater volatility, are also much more hazardous.

A more specialized use of mercurials is on tomatoes in glass-houses. On the basis of the pathological lesion discovered in his brain, the death of one individual three years ago was attributed to his use of ethyl mercury chloride. This compound is now a scheduled poison so far as its use in this way is concerned. Mercury is notorious as a chronic poison and the early signs of poisoning are often mundane and difficult to recognize. The possibility of prolonged and repeated exposure to mercury arises in a few occupations in agricultural practice.

Herbicides

The selective weed killers are now well known to gardeners as well as farmers. Based upon *chlorophenoxyacetic acid* they are widely used and, fortunately, those so far developed all have very low mammalian toxicity without evidence of cumulative effects.

Maleic hydrazide is another useful herbicide free of any important toxic effects, although for some time it lay under the suspicion of being carcinogenic. The basis for the suspicion was a rather slender analogy between

plant and animal tissues, but a series of experiments failed to produce any evidence that it did in fact have carcinogenic effects (Barnes *et al.*, 1957).

Dinitro-orthocresol (*DNOC*) is the weedkiller with the worst reputation as a poison and several severe and fatal cases of poisoning have occurred among men applying it to cereal crops in the early summer (Bidstrup and Payne, 1951). Introduced into clinical medicine twenty-five years ago as a slimming agent it was then responsible for a number of deaths attributable to its stimulant action on tissue metabolism. This is the effect it produces in the poisoned agricultural workers. The danger is probably greatest in hot weather, especially as the early symptoms of poisoning may be attributed by the victim to the natural discomfort of his environment. There is no specific therapy but there is experimental evidence which suggests that the use of barbiturates as a sedative in the treatment of DNOC poisoning may be dangerous (Edson and Carey, 1955). After absorption dinitro-orthocresol (DNOC) is carried round in the blood stream and a simple sensitive method exists for its detection. Although no exact correlation between blood levels and clinical poisoning has been established the presence of DNOC in the blood indicates that exposure has taken place. No further exposure should be permitted until the blood DNOC has been eliminated (Harvey *et al.*, 1951).

Sodium arsenite has been used on a considerable scale in the destruction of the haulms of potatoes to facilitate the use of mechanical lifters. Several mild cases of poisoning occurred when picking was allowed to continue in a field while another part was being treated with arsenite. There is a need for a cheap and effective non-toxic haulm destroyer. Sulphuric acid is not popular because of the general difficulty in handling it.

Bactericides

Streptomycin and chlortetracycline have recently been used as a treatment for certain bacterial diseases of fruit trees. Precautions to avoid gross exposure have been recommended but the possibility of previous exposure to an antibiotic should not be forgotten when agricultural workers require treatment for infection.

Conclusion

The practitioner who has agricultural workers among his patients may occasionally see a case in which poisoning is suspected. It is important to identify the material that was actually handled by his patient, because the majority of chemicals are not dangerous to apply, although they may, of course, be poisonous if accidentally or deliberately drunk in strong solution. When the nature of the active ingredient has been established specific treatment can be applied. A number of isolated cases has been reported in which conditions such as peripheral neuritis or agranulocytosis have developed in an individual who had been handling an insecticide such as DDT, and the disease has been ascribed to the compound handled. From among those most heavily exposed, however, there is no evidence that DDT, for example, is a cause of either of these conditions. The possibility of an individual idiosyncrasy cannot be dismissed but the idiosyncrasy might not necessarily have been to the insecticide but possibly to another chemical.

So far as is known the toxic chemicals used in pest control produce effects in man similar to those already shown in experimental animals. All such chemicals are tested in this way before approval for their use is given. That any of them will have additional effects only produced in man must always remain a possibility which can only be excluded by a careful study of any cases of real or suspected poisoning among those who handle the materials. The materials at present available for pest control can all be used safely. Ignorance, carelessness, or a disregard for human safety are the causes of accidents.

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Preparation	Chemical name
Aldrin	1:2:3:4:11:11:Hexachloro-1:4:5:8:9:10-hexahydro-1:4:5:8-diendomethylenenaphthalene
Amiton	o,o-Diethyl S-*B*-diethylaminoethyl phosphorothiolate
Captan	*N*-Trichloromethylmercapto-4-cyclohexene-1,2-dicarboximide
DDT (Dicophane)	2,2-Bis(*p*-chlorophenyl)-1,1,1-trichloroethane
Demeton	*o,o*-Diethyl *o*-2-(ethylthio)ethyl phosphorodithioate (I) (C_2H_5O)$_2$-PS.OCH_2CH_2.-SCH_2CH_3
Diazinon	*o,o*-Diethyl *o*-(2-isopropyl-4-methyl-6-pyrimidyl) phosphorothioate
Dieldrin	1;2:3:4:11:11-hexachloro-6:7-epoxy-1:4:5:6:7:8:9:10-octahydro-1:4:5:8 *dien*-domethylenenaphthalene
Endrin	1,2,3,4,10,10-hexachloro-*exo*-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-*endo*, *endo*-dimethanonaphthalene
'Lindane'	γ-1,2,3,4,5,6-hexachloro*cyclo*hexane
Malathion	S-(1,2-dicar-thoxyethyl)-*o,o*-dimethyl phosphorodithioate
Mipafox	Phosphorodi(*iso*propylamidic) fluoride
Parathion	*o,o*-Diethyl o-*p*-nitrophenyl phosphorothioate
'Phosdrin'	Dimethyl 1-carbomethoxy-1-propen-2-yl phosphate
Rogor	*o,o*-dimethyl S (N-methyl carboxamide) methyl phosphorothiolothionate
Schradan	Bis (dimethylamino) phosphonous anhydride
TEPP	Ethyl pyrophosphate
'Tritox'	Fluoroacetamide

Chemical names of some of the preparations discussed in the text

* A paper given at the Symposium on Industrial Medicine, published in "*The Practitioner*" and reproduced with their permission.

It is understood that Bristol Corporation is contemplating the pre-treatment of all timbers used in the building of their new housing estates.

"Horticultural Chemicals," a 1959 growers price list, has been published by Pan Britannica Industries Limited, and may be obtained from them on application to Waltham Abbey, Essex.

Control of Agropyron repens by trichloroacetic acid. Results from experiments and practical use in Norway.

* *by* ARNE BYLTERUD,

Norwegian Plant Protection Institute, Vollebekk, Norway.

Introduction

COUCH GRASS (Agropyron repens P.B.) presents the most urgent weed problem in Norway today. During recent years couch grass seems to have become more widespread, particularly in the districts where cereals are not grown in rotation with other crops. Many farmers will have to take fallowing under consideration if new methods for couch grass eradication are not found. During the last 25 years fallow has very seldom been used in Norway. If possible, the farmers avoid it, the loss of yield and the costs being too high. There is accordingly a great demand for effective chemicals against couch grass.

The demands made on the chemicals for control of couch grass are numerous. The effect against the weed must be satisfactory at a reasonable price, the application harmless to the operator, and last but not least, the chemicals must enable crops of economic value to be grown every year without any appreciable loss of yield. All these terms are relative, but the requirements should be met as far as it is possible.

A number of grass killers have been tested at the Weed Control Division of the Norwegian Plant Protection Institute. 125 trials were carried out during the years 1947-57. Trials in series are carried out in collaboration with the experiment stations. TCA, dalapon, sodium chlorate, MH, ATA, Chlorosol A, Monuron, CIPC, propham and ammonium sulphamate were tried. Of these, TCA has so far decidedly been of greatest interest to the farmers. Still, TCA does not solve the whole problem of couch grass. Cereals cannot be grown after a TCA treatment. The cropping has to be limited to species with considerable TCA resistance. This is undoubtedly an advantage, as the farmers are forced to use crops other than barley, oats and wheat in rotation.

The recommendations for the use of TCA in Norway differ in some respects from those of most other countries.

Climate and Soil Conditions in Norway

The distribution of rainfall varies widely between the different parts of Norway. In the best districts for cereal production, it ranges from 500 to 1500 mm yearly.

Normal rainfall and normal air temperature at the Agricultural College of Norway, Aas, are shown in figures 1 and 2. Aas is situated about 30 km. south of Oslo.

The growing season is short, lasting from about May 1st to October 1st. From late October to April, frost and snow may occur in greater or less degree. The change from winter to spring and from spring to summer is very rapid. The interval between snow melting and planting is often but 2-3 weeks.

The soil type changes within small areas. The humus content is higher than in warmer countries, and this probably leads to a greater activity of the micro organisms. Sand, loam and peat are the most common soil types.

RESULTS

Time of Application

TCA was first of all recommended for use during the active growing season of the couch grass. To avoid loss of yield, the treatment had to take place in early autumn after harvest. However, experiments during the first years showed clearly that early autumn was an unfavourable time for application. Single trials and series of trials were then started in order to determine the best time of application.

Table 1 shows the effect of TCA against couch grass in 26 field trials carried out in 1950-55. Early spring and late autumn treatments seem to have been most effective. In 1954 a series of trials were started. At that time we did not know the best rate of application and 75 kg. per hectare was chosen. This rate was too

heavy, but the influence of the time of spraying will be clearly seen from Table 2. Only trials laid out on wet soil early in the spring have been included in the table.

TABLE 1. **Control of couch grass. TCA sprayed at different times. 26 field trials.**

Time of spraying	% killed after the following rates of TCA per hectare				
	30	40	50	75	100
Early spring, wet soil	97[2]	98[2]	99[3]	97[2]	100[1]
Spring, dry soil	—	47[1]	42[1]	—	75[1]
Summer.. ..	—	—	13[2]	—	—
Autumn, before ploughing ..	—	—	41[4]	56[2]	53[4]
Autumn, on ploughed land	—	—	53[2]	79[2]	81[2]
Late autumn, just before frost ..	—	—	85[1]	95[2]	99[1]

[1]1 trial. [2]Mean of 2 trials. [3]Mean of 3 trials. [4]Mean of 14 trials.

TABLE 2. **Importance of time of application. Mean results of 11 field trials carried out all over Norway, 1954-57.**

	Untreated	TCA, 75 kg./ha.		
		In early autumn	In late autumn	In early spring
Percentage of couch grass plants killed at time of 1st row cultivation ..	—	67	64	97
Cover of couch grass estimated after harvesting, % cover	48	21	18	2

An effective control of couch grass is obtained only with application of TCA in late autumn, or early spring. In both cases TCA must operate while the couch grass starts growing in the spring. In 1956 the author, therefore, introduced a hypothesis to the effect that *lesser amounts of TCA are required to prolong the natural winter dormancy of the rhizomes, than to induce dormancy or kill the rhizomes during the period of active growth.*

In 1956-57 a glasshouse experiment was conducted to ascertain whether frost might have any influence upon the effect of TCA, and to test the correctness of the hypothesis mentioned.

Table 3 is taken from this experiment which included 80 pots. There is no doubt that frost may depress the viability of couch grass to a considerable extent, especially if the rhizomes have not gone through a natural, or suitable, process of hardening. The experiment showed plainly that the frost may kill the rhizomes (cf. table 3).

TABLE 3. **The effect of frost on hardened and unhardened rhizomes.**

TREATMENT	Shoot segments per pot harvested 8 weeks after the frost period 1957	
	Number	g.
Hardened rhizomes:		
Not frozen (ser. II, a) ..	40,3	16,5
Frozen 8 weeks (Ser. II, f)	37,0	17,6
Unhardened rhizomes:		
Not frozen (ser. I, a) ..	44,5	12,4
Frozen 8 weeks (Ser. I, i-h)	3,0[a]	1,4[a]

[a] Mean of 12 pots.

The best time for TCA application was just before the frost period. Treatment at the end of the frost period was also quite effective. Least effect was obtained for treatments on growing plants, 4 weeks after the frost period.

TCA influences the dormancy of the buds of the rhizomes. In pots treated with 30 kg. per hectare, shoots of couch grass emerged 16-20 weeks after application. No TCA reaction was noticed on these plants.

This fact stresses the importance of growing TCA-resistant row crops which enable cultivation during the season. Crops which give effective shadow in the autumn are preferable.

Rate of Application

In 1955 we realised that the actual rate of application was below 50 kg. per hectare. In 1956 a series of trials

was started in order to find the best rate of application. Colleagues in the other Scandinavian countries were interested in collaborating. Trials including the same rates of application are now being carried out in Denmark, Sweden and Norway.

The effect of TCA was not identical for the two years. The spring of 1956 was very dry. The total rainfall in April and May at Aas was only 31.6 mm. In these trials soils with high moisture contents gave satisfactory control of couch grass, for sprouts counted at the 1st row cultivation. On dry soil 50 kg. of TCA per hectare did not give much better eradication than 25 kg. The chemical was not distributed in the dry soil before the couch grass started growing. The row cultivation, however, was more effective in 1956 than in 1957. In 1957, preceipitation in April was somewhat below normal, but in May it was approximately normal. The effect of TCA was much more uniform in 1957 than in 1956. The final effect of TCA was just the same for the two years. In 1957 row cultivation was ineffective.

In these 61 trials 25 kg. of TCA per hectare gave satisfactory control of couch grass.

Results from practical use of TCA

After discussing yields after the use of TCA treatment, Mr. Bylterud said that on being introduced on the Norwegian market in 1951, TCA was soon used in practice. Unfortunately, the price was high and the effect of the large rates of applications in autumn unsatisfactory. As a result of this, the sale of TCA decreased in a few years. In the meantime research work had continued and in March 1956 new recommendations for its practical use were given. Late autumn, and particularly early spring, were considered very favourable times for treatment. Unfortunately the rate of application recommended was too high. 40 kg. of TCA per hectare severely injured some varieties of potatoes. Nevertheless, the differences in TCA resistance proved an interesting and valuable discovery. This phenomenon is now being studied in more experiments.

In order to take advantage of the sum of experience gained by the farmer, a survey was carried out in 1956 and 1957. 123 sites were visited and samples collected from 230 hectares. A lot of growers had cultivated many crops after TCA treatments, which makes the survey all the more valuable for further recommendations.

" In my opinion the aim of our research work will not have been reached until our conclusions and recommendations can be successfully applied in practice. In this case the recommendations have had to be altered somewhat, but the results obtained from experiments and practical experience seem now to agree very well. These practical sprayings have in turn aroused greater interest and goodwill with regard to research work and field trials."

The first year the survey covered treatments in both autumn and spring. The last year only one grower sprayed in the autumn. The interest was concentrated on early spring applications, which were considered to give more reliable results.

" I should like to stress the fact that recommendations for the use of TCA based on research and practical experience gained in Norway, cannot be transferred to countries with different climate and soil conditions, or to other species, varieties and strains. Norwegian experiments and practical experience have clearly shown differences in TCA resistance within the same species. It will easily be understood that greater differences are possible within soils and types of climate.

"Use of chemicals, as well as choice of plant species, rotation of crops and crop management must be adopted to the natural conditions existing in every country."

* *Abstract of paper given to the 4th British Weed Control Conference.*

MORE NEWS OF FISONS 18-15

REFERENCE was made in the December issue of "P.T." to what was believed to be the first agricultural press conference held on closed circuit television, anywhere in the world.

Firm responsible: Fisons Pest Control Limited: technical details: Pye Ltd.: programme introduced by Sir Clavering Fison.

Following on Sir Clavering's remarks, Dr. R. K. Pfeiffer, Head of Botanical Section, Chesterford Park Research Station, gave a Technical Survey of Fisons 18-15.

"Fisons 18-15 contained two active ingredients, the well known MCPA and another hormone type compound, 2,3,6 TBA," said Dr. Pfeiffer. "It is in my opinion important for you to realise that in one of these active ingredients (TBA) we have broken the tradition and have introduced for the first time since the discovery of 2,4-D and MCPA, a systemic hormone type substance for selective weed control in cereals which in many respects fundamentally differs from the rest of hormone weedkillers for cereal crops.

"MCPA, 2,4-D, CMPP, MCPB, 2,4-DB and 2,4,5-T after all, all belong to the same group of compounds which one could call Phenoxy compounds. Although each of these compounds has certain specific properties—MCPB is safe on clover, 2,4,5-T kills shrubs, CMPP controls cleavers—they all appear to work in the plant in a similar way and seem to be affected by environmental factors in a similar way."

"This means, as far as our Company is concerned, that in taking the revolutionary step of introducing a new type of hormone weedkiller, we have had to repeat on our own to a large extent all the pioneering work which had been carried out by many research stations for a number of years after MCPA and 2,4-D were introduced to agriculture."

Fisons Pest Control Limited hold an Inter-City Press Conference. Photograph shows—Sir Clavering Fison in front of the cameras.

Discussing practical aspects of Fisons 18-15, and its effect on crops, Dr. Pfeiffer said that last year's experimental evidence had already shown that correct timing of Fisons 18-15 was substantially different from the correct timing when using MCPA and 2,4-D. "Already in 1957 we emphasised that spraying Fisons 18-15 must not be done later than at the early jointing stage of the crop. The evidence I have just shown you confirms this recommendation as correct and we can therefore emphasise again for the next season the importance of early spraying as far as crop safety is concerned. If a farmer disregards our recommendations and sprays too late he is likely to find a certain number of sterile ears and in wet seasons an increased attack by certain fungi which lead to a blackening of ears," said Dr. Pfeiffer.

Regarding weed control, he observed: "Experiments carried out partly by us, partly by Government Research Stations and by our Agents in U.K., Belgium, Holland, Sweden, Denmark, Switzerland, Germany, East Africa

and Japan, have shown that Fisons 18-15 is well capable of controlling all weeds claimed with the sole exception of coltsfoot. In some of these countries a number of weeds which do not occur in this country and which are resistant to most other herbicides were also found to be well controlled with Fisons 18-15."

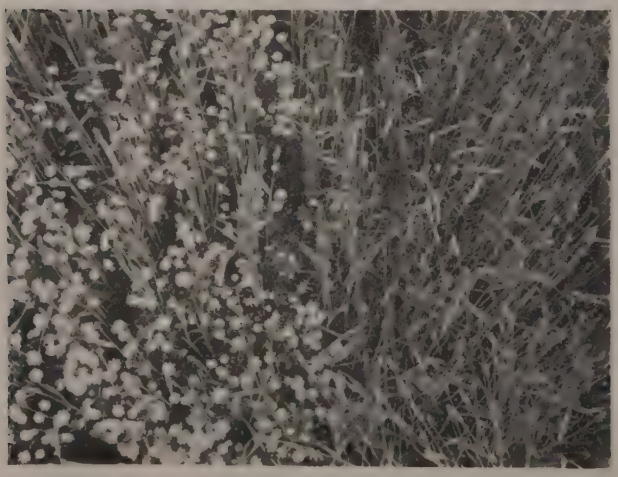
Recommendations were:

" 1. Weeds must be fully exposed to the spray when using Fisons 18-15. The dosage is rather critical and we cannot overdose to the same extent as we do when using Phenoxylene Plus to control charlock. The farmer cannot expect good results if the flag of the crop covers the weeds and allows only a fraction of the lethal dosage to reach the weeds.

" 2. Crop competition is essential to get best results. Weeds growing on poor patches or in very poor and thin crops are likely to get away. This does not only apply to Fisons 18-15 but to many other hormone weedkillers.

" 3. It has been confirmed that cold weather does not reduce the effectiveness of Fisons 18-15 on weeds. This is a very important advantage exclusive to Fisons 18-15.

" 4. Trichlorbenzoic acid appears to penetrate much more rapidly into the leaf than 2,4-D or MCPA.



Spring Wheat—Mayweed control with Fisons 18-15. Left hand side unsprayed. Right hand side sprayed on the 18th April 1958, and the photograph taken on the 7th July 1958, eight weeks after spraying. —Farm, Near Balsham, Cambridgeshire

This picture was shown on the closed circuit T.V. by Dr. Pfeiffer to illustrate his talk.

This would explain observations made in this country, in Sweden and in Japan, that rain following spraying of Fisons 18-15 affects its performance to a lesser degree than the performance of MCPA, 2,4-D or CMPP."

All facts clearly led to one conclusion which could be summarised in two words: *Spray early*

Mr. A. L. Abel, Technical Adviser, Chesterford Park Research Station, said they were very pleased when the results of research and development work indicated that CP 18-15, now called Fisons 18-15, was particularly effective against practically all those weeds not controlled by MCPA.

" Extensive trials through 1956, 1957 and 1958 have shown that Fisons 18-15 is very effective against mayweed, cleavers, chickweed and other weeds. It is non-poisonous and can be applied in low volume and has, therefore, the required properties of the farmer's ideal weedkiller.

"Unfortunately, neither Phenoxylene Plus nor Fisons 18-15 can be recommended for use on undersown cereals. It is true that under certain special circumstances low rates of Phenoxylene Plus have been successfully used against the readily controlled weeds such as charlock. But more generally it is necessary to use either New Legumex (MCPB) or Supersevtox (DNBP).

"Where the following weeds, for example, are the main problems in undersown cereals, New Legumex can be used: Charlock, Corn Buttercup, Pennycress, Fat Hen, Dock, Wild Radish, Creeping Thistle, Redshank, Knotgrass. It is a new formulation, similar to Legumex but containing a calculated amount of MCPA to improve the effect against such weeds as wild radish, charlock and fat hen. It is non-toxic and can be applied in low volume, although when the foliage is dense, improved results are obtained with higher rates, e.g. up to 40 gallons per acre. New Legumex has, therefore, many of the desired properties. As far as consistency of performance is concerned, it is a new product for 1959, but from our research and development results we are confident that it will eventually prove itself on this score as well. New Legumex is a hormone weedkiller and when the hormone-resistant weeds such as mayweeds, chickweeds, cleavers, etc., occur in undersown cereals we must use another weedkiller. Here progress has not been as great as in the other directions, and the most effective chemical is one based on DNBP, namely *Supersevtox*. It is yellow

As it was received in Manchester. Sir Clavering introducing the programme. Reports from all sections were of first-class reception.

staining and toxic and, therefore, requires careful handling. It can be applied in low volume, but it is preferable to employ volumes of 60 gallons per acre or more. It is contact in action and produces a rapid effect against the following weeds: Fat Hen, Pennycress, Charlock, Wild Radish, Hemp Nettle, Poppy, Mayweeds, Chickweed, Cleavers."

Speaking on " Commercial Appreciation of Fisons 18-15," Mr. H. G. Rope, Sales Director, Fisons Limited, observed that 1957 was a phenomenal test year for all weedkillers.

" Perhaps we were fortunate, in a way, to have met the worst competition that nature could supply. We have always recognised that wide variations in weather conditions play a significant role in product performance. In other words, we don't make products that will only work successfully when the weather is favourable, and in the Fisons 18-15 formulation we have made an adjustment which ought to take care of every eventuality. Although the new formulation is more expensive to make, the additional cost has been absorbed in the new price."

The cost to the farmer, bearing in mind rebates for early purchases, was only 30/- per acre.

THE SMITHFIELD

SOME YEARS AGO the writer sat in a car driving through a lovely Welsh valley: in the distance loomed a magnificent set of buildings with some new houses clustered in the vicinity. He was on his way to see the then novel development in British textiles—the new factory at Pontypool for the production of Britain's nylon yarn—the factory of British Nylon Spinners Limited.

"And what do you call it?" he asked the liveried chauffeur who had a lifetime of rural Wales behind him long before things like Development Areas were known.

The pleasing Welsh voice replied: " We call it The Nylon." And at once, nylon was in its rightful place: it was " The " Nylon—something more than mere nylon.

In the same way, Smithfield is more than just a name: it is " The Smithfield " with so many people — and rightly so.

Thus, in the spirit of " The Smithfield " let us have a quick look-see at what this year's show had to offer in the way of new developments.

Micron Sprayers Limited showed an automatic concentrate sprayer mounted on the tractor 3-point linkage and driven by the tractor. Rotary atomisers produce droplets of uniform size, and this size may be controlled. Twin outlets are fully adjustable for single or double-sided spraying of top fruit, hops, coffee, cocoa, and many other crops.

E. Allman and Co., Ltd., showed their new " Rapid " Sprayer for the first time at this exhibition, this being a push-type unit particularly suitable for the application of weed killers to sports' grounds and equally suitable for the horticulturist.

A price reduction was also announced of some of the firm's popular lines of sprayers, following on increased production during the winter months.

Cooper, Pegler and Co., Ltd., exhibited new equipment which included the 15' Aluminium Telescopic Lance, Low Volume Nozzle and Cone Spray Nozzle.

The Telescopic Lance is for spraying high trees, walls etc., with a spray or jet 20-25 ft. from the ground. The Low Volume Nozzle has been designed to give protection to the Ceramic tip and the new range of Cone Spray Nozzles includes a Single Fixed and Double Fixed, Single Swivel and a Variable Spray Nozzle.

A new machine on view was the " Dustmaster " and " Dustox " manufactured by J. W. Chafer Limited, Agricultural Chemical Manufacturers of Milethorne Lane, Doncaster.

The machine was first used for potato spraying trials and has a narrow row and high clearance wheels with special stub axles and dividers. Described as " a precision farm instrument " specially designed for applying the new micronised dusts, the company observes:

> " We believe the machine and the dusts are complementary and mark an outstanding achievement in the fight against disease and pests."

The Company has built up a sprayer hire-service, too, incorporating technical advice, crop inspections and complete overhaul.

Timing, it is said, is all-important and the only acceptable method of blight control is one of continuous prophylactic treatment.

" Two or three sprayings at 10 day intervals commencing when blight first appears, is of no use," it is claimed. " Judgment of blight control is all very easy in a year of exceptional weather conditions but an overall view taken over a number of years will give a truer picture. Danish experiments over a period of 24 years established that 15% of the crop was lost through non-spraying for blight every year."

The Midox Company, specialists in low volume fruit spraying demonstrated the " Mounted " R.S.M. Sprayer incorporating the R.S.M. Blower Unit. The machine has been designed for the man with a smaller acreage of fruit and awkward corners in which to work. It may be used for concentrate or lance spraying and has a tank capacity of 65 gallons—enough to spray 3 acres at low volume.

A/S R. Sigvardt Motorfabriken, Orehoved, Denmark, showed their " Popular " Power Sprayer, all-purpose equipment, and also the " Popular " Model SG equipped with detachable carrying handles. For changing to wheel propulsion, it is only necessary to unscrew two bolts.

Watson Sprayers, Swanley, Kent, demonstrated their new Mistblower-Duster, which is a multi-purpose and tractor mounted machine.

May and Baker Ltd., had a range of selective weedkillers, viz.:

" Agritox " MCPA. A general purpose selective weedkiller for use in cereals, grassland and linseed.

" Tropotox " MCPB. The original MCPB selective weedkiller, for use in clovers, cereals, grasses, sainfoin, peas, and dredge corn containing peas.

" Tropotox " Plus. An improved formulation of " Tropotox " for use in undersown cereals and direct seeded leys. Recommended especially where there are heavy infestations of cruciferous weeds such as charlock and seedling runch.

" Planotox " butoxyethyl ester of 2:4-D. An economical and rain resistant weedkiller for use in wheat, barley and winter oats, grass for seed and grassland. Especially valuable against the more difficult weeds.

" Compitox " CMPP. A low volume weedkiller which besides giving good general weed control, also kills chickweed and cleavers.

" Embutox " 2:4-DB. The only safe weedkiller for use in seedling lucerne and white clover grown for seed.

" Varitox " T.C.A. For pre-sowing treatment of sugar beet and peas to control wild oat, and for post-harvest control of couch grass.

" Sponotox " 2:4:5-T. An economical spray for killing brushwood or scrub in headlands, hedges, and weed-breeding areas.

At the stand of Shell Chemical Co., Ltd., the company's new nitrogenous fertiliser Nitra-Shell 23, which contains 23% nitrogen, was exhibited, as well as a wide range of weedkillers.

Baywood Chemicals Limited exhibited a range of products which included the systemic insecticide Metasystox, Morkit Bird Repellant, the Ialine range of Weedkillers (MCPA, 2,4-D, CMPP, DNOC and DNBP), Ialine Potato Blight Spray and Ialine DDT Emulsion.

NEWS

U.K. INSECTICIDE EXPERT VISITS AFRICA

Dr. T. F. West, D.Sc., Ph.D., F.R.I.C., European Operations Executive of the African Pyrethrum Technical Information Centre Ltd., left by air 2nd December, 1958, on a short visit to Kenya and the Belgian Congo.

One purpose of his trip is to compare the results of U.K. research into the use of Pyrethrum based insecticides with those of the work of scientists at the Nakuru laboratories of the Pyrethrum Board of Kenya, and to draw any consequent conclusions about possible wider use of the product of this important African industry.

Pyrethrum, an age-old natural insecticide, is coming increasingly to the fore now that insects are developing resistance to synthetic insecticides. It is not only harmless to humans and animals, but no significant case of resistance to it has been reported.

Dr. Frank M. Strong, professor of biochemistry at the University of Wisconsin, has been elected chairman of the American Chemical Society's Division of Agricultural and Food Chemistry for 1959. He succeeds Dr. H. H. Haller of the United States Department of Agriculture, Washington, D.C.

Dr. Lloyd W. Hazleton of the Hazleton Laboratories, Falls Church, Va., was named chairman-elect of the ACS division, and Dr. John H. Nair III of the Mellon Institute, Pittsburgh, was re-elected secretary-treasurer.

Professor Strong, who won the Borden Award of the American Institute of Nutrition in 1956, has carried out important studies on the chemistry of the B vitamins, and the distribution in food of vitamins and amino acids (building blocks of protein). He has written some 100 scientific papers describing his research.

At the annual dinner of the Industrial Pest Control Association. Left to Right: Mr. D. J. S. Hartt, Vice-President of the Association, Mr. A. Fraser McIntosh, President, and the Right Honourable Earl Waldegrave, Parliamentary Secretary (Lords) to the Ministry of Agriculture, Fisheries and Food, principal guest.

Mr. W. K. McGavin has been appointed manufacturing director of Shell Chemical Company following the retirement of Mr. F. Mackley. Mr. McGavin, who was born in Australia, has held a number of overseas appointments during his career with Shell, the last one as refinery manager at Suez.

Other appointments on the manufacturing side include: Dr. J. L. Edgar, Manager, Manufacturing Operations Department; Mr. J. O. Dugdale Bradley, Manager, Engineering Department and Mr. L. Holliday, Manager, Technological Department. The Manufacturing Division has moved from Clements House, 14/18 Gresham Street, E.C.2, to the Company's offices at Marlborough House, Great Marlborough Street, W.1.

At the company's chemical plants, Mr. R. W. Lerrigo becomes Chemical Plant Manager at Stanlow near Chester and Mr. E. J. Dawson, Chemical Plant Manager at Shell Haven, Essex. At the Partington Works near Manchester, Mr. W. E. Huggett, the General Manager will be assisted by an Administrative Manager, Mr. F. W. A. Paterson and an Operations Manager, Mr. H. L. Sturgess.

Mr. R. C. Dickie, M.A., Works General Manager of Marchon Products Limited, Whitehaven, has been appointed to the Board of Directors. Mr. Dickie joined the Company in 1946 as Chief Chemist.

Mr. O. Secher, a Director of Marchon Products Limited in charge of sales, has now been appointed to the Board of Solway Chemicals Limited, Marchon's subsidiary company.

Both companies are members of the Albright and Wilson group.

Mr. J. H. W. Turner has been appointed to the Board of Hardman and Holden Limited in charge of research and development.

Mr. H. S. Land, previously Chief Chemist, has been appointed Consultant to the Board.

BOOK REVIEWS

Reports on the Progress of Applied Chemistry. (Vol. XLII) 1957.

Published by the Society of Chemical Industry. 14 Belgrave Square, London, S.W.1.

This is a comprehensive volume extending to 910 pages, including the name index and subject index which together extend to 190 pages.

For the pest technologist interest will be especially centred on pages 595-623 inclusive, Control of Pests by Members of the Pesticides Group, (Convenor: J. K. Eaton, M.Sc. Tech., Ph.D., F.R.I.C.) (Woodstock Agricultural Research Centre, Sittingbourne, Kent), and which includes Organo-phosphorous Insecticides (A. H. M. Kirby, M.Sc., Ph.D. F.R.I.C.) (East Malling Research Station), Control of Plant Nematodes (F. Call, B.Sc., Ph.D., and N. H. Hague, B.Sc.), (Imperial College of Science and Technology), Herbicides (R. G. Powell, B.A.) (Department of Agriculture, University of Oxford), The Analysis of Herbicides (W. H. Stephenson, F.P.S., D.B.A., F.R.I.C.) (Boots Pure Drug Co., Ltd., Nottingham) and Application of Concentrated Sprays (J. B. Byass, M.A.) (National Institute of Agricultural Engineering, Silsoe, Beds.).

The volume is a mine of information (to use a somewhat hackneyed phrase!) and of the published papers to which reference has been made, an important feature is the list of references which follows each.

Pesticides Economic Poisons, 1956-57 Special Publication No. 268.

Published by the State of California Department of Agriculture, Sacramento.

This is an extremely useful publication and refers to drawn samples during the year under review and reports thereon. Products by the leading American chemical companies are listed and from the statistical viewpoint alone the volume is one well worth having.

Fertilising Materials 1957 Special Publication No. 269.

Published by the State of California Department of Agriculture, Sacramento.

Another publication from Sacramento well worth having. The contents include analyses of commercial fertilisers and is well supported by a wealth of statistics.

The Open Door to Plenty.

Published by the National Agricultural Chemicals Association, Associations Building, Suite 603-604, 1145 19th St., N.W., Washington 6, D.C.

Described as " the facts book of the pesticides industry " this 64 page illustrated booklet reviews progress which has been made and reports on anticipated future benefits. Stages in the development of a new pesticide and application methods are all listed and illustrated.

Nomenclature is listed at the beginning for various pesticides.

PUBLICATIONS RECEIVED

Spraying Materials and Services.

Published by E. C. Longmate Limited, Terrington St. John, Wisbech, Cambs.

This reference book which has been compiled by E. C. Longmate, brings to the notice of farmers and fruitgrowers new techniques in the control of pests.

Chemical Year Book 1959.

Published by Bradford and Sons Ltd., Yeovil. Price 2s. 6d.

This is a very well-produced Year Book and reflects great credit on the firm concerned, the more so when one reflects that it was only twelve years ago that the Company sold its first hundredweight of Agroxone powder.

A foreword by Michael Bradford, " This is our Story " is well worth reading and there is some good advice, " How to get the best from your Sprayer " as well as a comprehensive reference to a wide range of chemicals for weed control purposes.

The Roche Courier.

Published by Roche Products Ltd., 15 Manchester Square, London, W.1.

A review of subjects of current interest to the medical profession.

Brief Information of Pesticides of Current Interest.

By Robert Z. Rollins, Chief, Bureau of Chemistry. Published by State of California, Department of Agriculture, Bureau of Chemistry, Sacramento.

A summary of some facts about pesticides which have recently appeared on the market or are soon to be marketed in California and pesticides whose scope of use is in process of active development or of current interest.

Apparently more than 12,000 products are registered for sale in California and additional products are registered every day.

Esso Magazine. Volume VII, No. 4.

Published by Esso Petroleum Company, Ltd., 36 Queen Anne's Gate, London, S.W.1.

The story of the neglected port of Milford Haven is only one of eight entertaining articles, all well illustrated.

Herbage Seeds Mixtures. Advisory Leaflet 454.

Published by H.M. Stationery Office, Price 3d. net.

An informative leaflet which succintly introduces the subject and gives some suggested seeds mixtures.

Forestry Commission Leaflets. No.'s 19 and 44.

Published by H.M. Stationery Office, prices 9d. and 1s. 0d. net respectively.

Leaflet No. 19 " Elm Disease " is a revised publication. Well illustrated, the leaflet comments, referring to the present position:

> " The risk of disease is now low enough to suggest that planting of elms is justified, except as avenues when the loss of one tree can damage the whole lay-out."

Leaflet No. 44 " Voles and Field Mice " is by Professor F. W. Rogers Brambell, D.Sc., F.R.S., Department of Zoology, University College of North Wales, Bangor.

Well illustrated review comprising some 11 pages.

Plastidry Hose for irrigation and emergency water supply.
(*see page 93*)

Ernest Rhodes, Director of Rhodes Industrial Services Limited, the publishers of " Pest Technology, Pest Control and Pesticides " has been elected Honorary Secretary of the National Spastics Society, one of Britain's leading charities.

A member of the Executive Committee for the past five years, he has been active in the spastics' movement from its early days: he was a founder member of the Stockport and District Spastics Society, in 1953, and was elected its first Chairman, a position he still occupies. The Society now owns Granville House, Stockport, where 34 spastic children attend daily for education and treatment. Alterations and extensions have just been completed at a cost of £6,500.

He was the first Chairman of the North Region of the National Society and also serves on the Employment Committee of the N.S.S.

He is the father of a spastic child, Frances Hilary.

In one of his recent Sunday A.T.V. Television talks " It can happen Tomorrow," the science reporter Mr. Ritchie Calder, O.B.E. said that not long ago the United Nations had received a report from one of their field workers in Indonesia that a new species of malarial mosquito had appeared which was immune to man-made insecticides.

NEWS

Mosquitoes are now challenging the synthetic insecticides which have hitherto done so much to wipe out malaria in certain parts of the world.

Mr. Calder spoke of a " natural insecticide which has been grown for thousands of years, named Pyrethrum, which is now grown mainly in Kenya."

Insects, in fact, have shown no significant resistance to Pyrethrum although it is known to have been grown and used as an insecticide for at least 2,000 years.

Although overall supplies of grass seeds are considered to be adequate for 1959 sowings, a serious shortage is expected of all home produced Red and White Clovers: imports should be sufficient to meet these deficiencies.

Chemical sprays: Crop damage

The Minister of Agriculture said in the Commons on 4th December that the Association of British Manufacturers of Agricultural Chemicals and the National Farmers' Union have agreed to meet to consider the question of compensation arising from damage caused to growing crops by chemical spray drift.

BP Detergents Ltd.

BP Detergents Ltd. has been adopted as the new name for Irano Products Ltd., a BP Company which was formed in 1945 to distribute By-Prox and Comprox detergents, and, more recently, has in addition marketed paraffin wax and paraffin coke.

By-Prox, a general purpose detergent, and the Comprox industrial range are produced at BP's Pumpherston Refinery largely from products of the Scottish shale oil industry. Comprox "A" has the distinction of being the only detergent of its type produced in the United Kingdom entirely from indigenous materials.

These detergents are marketed for use in industry, including laundries and textile factories, agriculture and the catering trade, both in the United Kingdom and overseas. By-Prox is retailed for domestic use in Scotland.

DATES FOR THE DIARY

(*Hon. Secretaries are invited to send in details for inclusion in this column*).

6th January, 1959.

Plant Phenolics Group. Meeting: " Chemistry of Condensed Tannins." Chairman: Prof. R. D. Haworth, F.R.S. Speakers will include Drs. B. Brown, D. E. Hathway, W. E. Hillis, E. A. H. Roberts, D. Roux and T. Swain. Queen Elizabeth College, London, W.8 (further information may be obtained from the Hon. Sec., Dr. T. Swain, Low Temperature Research Station, Downing Street, Cambridge).

9th January, 1959.

Association of Applied Biologists.

After the formal business of the meeting there will be a symposium on:—" Insects and Public Health."

11-00 a.m. Dr. J. Keiding (*Statens Skadedyrlaboratorium, Denmark*) : " Housefly control and resistance to insecticides in Danish farms."

11-40 a.m. Dr. J. R. Busvine (*London School of Hygiene and Tropical Medicine*): " Insecticide resistance in bed bugs."

11-55 a.m. Mr. R. J. Wood (*London School of Hygiene and Tropical Medicine*): " Insecticide resistance in mosquitoes."

12-10 p.m. Discussion—opened by Dr. E. A. Parkin (*D.S.I.R. Pest Infestation Laboratory, Slough*).

12-40 p.m. INTERVAL FOR LUNCHEON.

2-00 p.m. Dr. D. S. Kettle and Dr. R. H. Parish (*Zoology Department, University of Edinburgh*): " The control of biting midges in Scotland."

3-00 p.m. Discussion—opened by Dr. A. Milne (*A.R.C. Unit of Insect Physiology, Newcastle-on-Tyne*).

3-30 p.m. Dr. B. C. Hobbs (*Food Hygiene Laboratory, Central Public Health Laboratories*): " The significance of insects in the contamination of foods."

4-00 p.m. Discussion—opened by Dr. Dr. J. A. Freeman (*M.A.F.F. Infestation Control Division, Tolworth*).

Visitors are cordially invited to attend.

In the Meeting Room of the Royal Entomological Society, 41 Queen's Gate, London, S.W.7.

" Chickweed has been found to be extremely susceptible . . . . "

Weed Control Abstracts—*continued.*

FURTHER WORK WITH CMPP IN CEREAL CROPS

By G. B. Lush, E. L. Leafe, and A. J. Mayes.

Boots Pure Drug Co. Ltd., Lenton Experimental Station.

Part I. Weed Control

Introduction

The weed control data presented in 1956 showed that when sprayed at the rate required to control cleavers, CMPP also controlled chickweed and a range of MCPA susceptible weeds. No data was given regarding the relative susceptibility of these other weeds but a general resemblance to their reaction towards MCPA was indicated. Further work was clearly indicated here.

It was suggested that early spraying of cleavers night not be as effective as spraying at later stages and this was scheduled for further investigation.

Evidence was given demonstrating the efficacy of CMPP applied in gallonages down to 20 gallons per acre, but no information was available concerning the effect of lower volumes than this. The trials referred to in this part of the paper were designed to extend our knowledge of these aspects. In addition, work was also planned to compare the amine and potassium salt formulations of CMPP.

Conclusions

The excellent control of cleavers with CMPP at 2.4 lbs. per acre has been confirmed. Early spraying of this weed gives satisfactory control provided climatic conditions are favourable.

Chickweed has been found to be extremely susceptible to CMPP at rates from 1.6 lbs. per acre. The climatic requirements for control of this weed are almost negligible, good control being possible under very unfavourable conditions. Under these circumstances 2 lbs. per acre should be used.

A number of weeds can effectively be controlled when spraying for chickweed at 2 lbs. per acre and a further number is adequately controlled when spraying for cleavers at the 2.4 lbs. rate. Amongst the latter are the campions and scentless mayweed, weeds not significantly controlled by MCPA or 2,4-D.

Extensive work has shown that both amine and potassium formulations of CMPP can confidently be expected to give the same degree of weed control.

FURTHER WORK WITH CMPP IN CEREAL CROPS.

By G. B. Lush, E. L. Leafe, and A. J. Mayes.

Part II. Crop Safety

At the Third British Weed Control Conference in 1956, the discovery of the value of CMPP as a herbicide was first announced (Leafe, E. L. Lush, G. B.).[1] It was shown that, in the major cereals, although the period of susceptibility to CMPP was largely similar to MCPA the degree of damage following spraying during the susceptible period was very much less. The advantages, from the weed control standpoint, of early spraying, or, more important, maximum latitude in spraying, have been discussed in the previous paper.

It was known that spraying with MCPA during the susceptible period gives rise to damage, the extent of which is appreciably dependent on cereal variety and furthermore on environmental conditions (Anderson, S.[2] Elliot, J. G.[3]). It was against this background that, in 1956, it was decided to defer recommendations for early spraying with CMPP until varietal response and the effect of environment had been investigated more fully. This work has proceeded during the last two years.

The experimental work was designed to evaluate the susceptibility of a wide range of cereal varieties, some established and some of recent introduction, when sprayed with CMPP, particularly during the early phases of growth, when they are characteristically susceptible to MCPA and 2,4-D.

Wheat is susceptible prior to and during double ridge, glume and early pale initiation but after this stage, except at a very late stage, damage does not occur. In barley the situation is analogous and the safe stage is reached once pale initiation is well established. The development of the fifth leaf on the main stem is the accepted practical indication that the safe stage of development has been reached in spring wheat and barley.

In oats the situation is more complex and factors other than stage of development tend to be over-riding.

Two types of trial, complementary in purpose, were employed:—

1. Small triplicated trials which were assessed by visual observation of head abnormality. This type of trial was employed to determine varietal susceptibility to CMPP and were variously situated in Nottinghamshire, Lincolnshire, Ayrshire and Angus. and,

2. Yield trials in which a larger plot size and a larger number of replicates were used. This type of trial was employed to determine the effect of CMPP on the yield of selected wheat, barley and oat varieties and furthermore to correlate yield depression and head abnormality. Sites were chosen which showed even fertility and germination, and which showed promise of remaining weed free, thus allowing a direct comparison of treatment and untreated control without the interference of a weed control factor.

The outstanding feature of the trials with wheat is the susceptibility of the varieties Atle and Atson when sprayed during the early stages of double ridge initiation. At Grimsby in 1957 there was apparent anomaly in that only a negligible number of abnormalities occurred in these two

" spraying may be carried out at the early stages of cereal growth . . . . "

In the picture may be seen—

R. L. Harpur, Fisons Pest Control Ltd., A. L. Abel, Fisons Pest Control Ltd., J. L. Hunt, Shell Chemical Co., Ltd., R. W. Legg, Fisons Pest Control Ltd., L. P. Flipse, Rotterdam. P. A. Oram, M.A., Dip. Agric., Head of Agricultural Department, Borax Consolidated Limited.

varieties after spraying during double ridge initiation, that is at the 3-4 leaf stage. At Woodborough and at Linby in 1957 a high proportion of abnormalities ensued after spraying at this stage and, in 1958, at Woodborough, Sibthorpe and Thurgarton this pattern was repeated. It may be that the stage when CMPP causes abnormalities in wheat is extremely critical, i.e. after double ridge initiation but before appreciable suppression of the lower part. At Grimsby, where abnormalities did not occur, there was appreciable suppression of the lower part of the double ridge at the 3-4 leaf stage whereas in the other instances there was no suppression or very little. This point will be further investigated. The yield results confirm the sensitivity of these two varieties during double ridge initiation.

The variety Koga II has consistently shown resistance to damage at all stages of growth, both in variety and yield trials. The results obtained with other varieties of spring wheat require more consideration before any conclusion can be drawn.

In the case of winter wheat, spraying in the spring is unlikely to be carried out until weather conditions are suitable. Generally by then the crop will be well tillered and a safe stage of development reached. It should be borne in mind that leaf number does not bear the same relationship to apex development as in spring crops nor is it the constant relationship found in spring wheat and barley. The variety Capelle, sprayed with CMPP at 2.4 lbs. acid equivalent when well tillered, gave rise to no abnormalities and suffered no yield reduction.

Conclusions

The past two years' work has added considerably to our knowledge of the effect of CMPP on cereals.

It has been shown that on a wide range of barley and oat varieties, where weed growth makes it desirable and weather conditions permit, spraying may safely be carried out at the early stages of cereal growth. Spring oats and barley may be sprayed from the one to two leaf stage onwards but should not be sprayed once the " jointing " stage has been reached.

The position in wheat is more complex. Whereas the varieties Atle and Atson are damaged when sprayed during double ridge initiation, that is, when the leaf stage is between two and four, Koga II is safe at all stages. Koga II may be sprayed from the one to two leaf stage up to the " jointing " stage. Atle and Atson and, at present, other spring wheat varieties may be sprayed between the five leaf stage and "jointing." Spraying before the five leaf stage may give rise to abnormal heads and yield reduction.

REFERENCES

1 Lush, G. B. and Leafe, E. L.—*Proc. British Weed Control Conf. 3rd Meeting.* (Blackpool, England Nov. 6-8, 1956). p. 625-640.

2 Anderson, S.—*Proc. British Weed Control Conf. 2nd Meeting* (Harrogate, England. Nov. 2-4, 1954). p. 395-399.

3 Elliot, J. G.—*Proc. British Weed Control Conf. 3rd Meeting* (Blackpool, England, Nov. 6-8, 1956). p. 399-415.

" . . . . no published figures available for comparison."

THE TOXICITY OF SEVERAL WEEDKILLERS, ALGICIDES and FUNGICIDES TO TROUT.

by J. S. Alabaster, *Ministry of Agriculture, Fisheries and Food, London.*

Since the last note on the toxicity of weedkillers to trout (Alabaster, 1956) a number of proprietary weedkillers, algicides and fungicides and also several chemicals forming the active ingredient of such substances have been tested for their toxicity to trout.

Rainbow trout (*Salmo gairdnerii*) and in some cases also Brown trout (*Salmo trutta*) were tested in several concentrations of each substance over a period of several days. The fish were between 3 and 12 months old although only fish of the same age were used for testing any one substance. They were sorted at random into batches of 10 and acclimatised for at least 24 hours in 40 litre test aquaria in which the temperature was 18°C ± 0.5°C and the dissolved concentration close to the air saturation value. The fish were starved during this time and during the test period which immediately followed. Where possible the individual periods of survival of the fish were recorded and the median survival time estimated by the graphical method of Bliss.

The results for the different substances are not strictly comparable because with some the test solutions were renewed daily whereas with the rest they were not. With batch replacements of the solution estimates of the 48 hour median tolerance limits could be lower than they would be in static conditions. The toxicity of a weedkiller which is to be applied only once to water containing fish may thus be over-estimated in a test in which the solution is renewed, and conversely, the toxicity of substances such as fungicides in paper-mill effluents which are discharged continuously to rivers may be underestimated by tests carried out with little or no replacement of the test solution. With some of the substances listed in the table additional tests were carried out under different conditions of replacement. With No. 6 a continuous rate of replacement of 0.25 1/min was used and with Nos. 10, 13 and 15 a flow of 1.0.1/min was tried. In the case of number 10 the results were similar to those obtained with daily batch replacement and with the others the results were similar to those found under static conditions. With No. 8 additional tests were made in solutions containing initial concentrations of 40 and 80 p.p.m. which were charged daily and in solutions with the same initial concentrations which were not charged. At the end of 4 days the percentage mortality in the solutions which were changed was 10 and 50 respectively and in the static solutions, 0 and 10 respectively.

There are no published figures available for comparison for the formulated substances and only a few for the pure chemicals. Heron and Sproules quote figures for sodium pentachlorophenate which are similar to those presented here. However they say that 0.01 p.p.m. of phenyl mercuric acetate is regarded as a safe upper limit for fish whereas in the tests reported here trout died within 24 hours in this concentration.

EXPERIMENTS on the CONTROL of AQUATIC WEEDS by means of COPPER SULPHATE.

by R. J. Chancellor, A. V. Coombs and H. S. Foster

A.R.C. Unit of Experimental Agronomy, Department of Agriculture, Oxford University.
The British Sulphate of Copper Association Ltd., No. 1 Great Cumberland Place, London, W.1.
McKechnie Brothers, Limited, Widnes, Lancashire.

Spalding Experiment

(a) *Location and site.* A channel known as Lock's Dyke forming part of the Deeping Fen, Spalding and Pinchbeck Internal Drainage Boards network was chosen for the trial. It was fed with water of pH 7.8 from a river through an adjustable sluice so that an approximately constant rate of flow could be maintained. The rate of flow aimed at was 200 to 250 galls./minute. The channel consisted of 3 sections, each perfectly straight and uniform, of a total length of 1¼ miles, and the width of the water was about 4 feet, varying a little according to its level. The first 250 yards was left untreated as control.

(b) *Treatment.* Copper sulphate was added by allowing it to dissolve from bags suspended in the water from a plank across the dyke. The number of bags necessary was ascertained by estimating the copper content of the water from time to time. A concentration of 1 p.p.m. copper (copper sulphate 4 p.p.m.) was aimed at. This was eventually obtained by the use of about 5 bags into one or two of which 13 lb. of copper sulphate (granulated) was put daily. With copper 1 p.p.m. 200 yds. below the treatment point the copper concentrations at 1000 and 2000 yards averaged 0.6 and 0.4 p.p.m. respectively. The treatment started on April 1st, 1957 and continued for 6 months, consuming altogether 1 ton of copper sulphate.

(c) *General results.* The effect of the treatment on algae, which was complete control, soon became evident and persisted throughout the duration of the treatment and was seen not only in the dyke but also to some extent in the main channel into which it was discharged. The comparison of the growth of other weeds in the treated area with those on the control section was difficult because in the control section the plants were densely coated and matted together with algae. The effect of the treatment on flowering plants appeared to be negligible beyond the first 100 yards for the first 4 months although *Lemna minor* (duckweed) disappeared. By the end of September general weed growth was much less vigorous for at least half a mile and certain species (see Table 1) had disappeared. The Engineer to the Drainage Board described the total growth as very moderate, but probably sufficient to require manual clearance in ordinary circumstances and in December this was done. After treatment ceased, on October 1st, the site was kept under observation. The regrowth which took place in the spring seemed to be about normal in quantity, but species which had disappeared the previous year were still absent.

" promising result of first experiment . . . . "

Louth Experiment (Lincs.)

(a) *Location and site.* In a channel under the care of the Louth Drainage Board at South Somercotes a trial was made similar to that at Lock's Dyke, Spalding. The control was the channel from which the experimental dyke was fed and contained the same plants as the treated area. Although controlled by a sluice gate the rate of flow of the water (pH 7.2) was somewhat uncertain and irregular.

(b) *Treatment.* The copper sulphate treatment (21 lb. every 2 days, dissolving from suspended bags) was started on May 23rd, 1957 and continued to November 14th. This was calculated to give a copper concentration of 1 p.p.m. and a series of observations showed this at 1,100 yds. from the treatment point. At a mile below never more than traces of copper were found. Much higher concentrations were sometimes found near the treatment point but these were irregular and were probably influenced by the lapse of time since re-filling the bags. This dyke had more side drains leading into it and more connections with other channels than the one treated at Spalding and this probably accounts for the more rapid decrease in copper content downstream.

(c) *General Results.* The dyke was originally well stocked with common weeds and like the other water courses in this system suffers periodically from growth on the water surface of a thick algal scum, locally called " skin." In August *Myriophyllum spicatum. Elodea canadensis* and *Potamogeton densus*, which had formed dense masses ¼ mile below the treatment point, had disappeared and dying stems on the bottom confirmed their control. Other species appeared unaffected (see Table 1), but in general the total growth was considerably reduced. In September when the Drainage Board had the dyke cleaned in the usual way the Engineer reported that the growth removed was much less than usual. In the spring the volume of new growth could not be said with certainty to be below normal. *Myriophyllum, Elodea* and *Potamogeton* had not re-appeared up to mid-June. Algal growths were again normal having presumably floated down from the control section, and *Callitriche stagnalis* was flourishing.

Tickenham Experiment (Somerset)

(a) *Location and site.* This is the site described at the 1956 Weed Control Conference.[1] The stream had been treated with copper sulphate in the summer of 1956 and the resulting suppression of growth of *Callitriche spp.* continued until May 1957, the stream remaining practically clear of weeds over a distance of about half mile. By Mid-June, however, growth mainly of *Callitriche spp.* was so vigorous that the Drainage Board ordered its clearance. Following this, regrowth was approximately normal.

(b) *Treatment.* In view of the promising result of this first experiment, weed control having been obtained for about 8 months, but at a rather heavy cost, it was decided to try the effect of a smaller dosage beginning in August 1957, using the same stream. The treatment point was moved downstream 150 yards, thus giving an additional control portion of the stream. The average rate of addition aimed at was a quarter of that used in 1956, viz.: 0.25 p.p.m. copper in the water and was obtained by suspending a bag containing 28 lbs. of copper sulphate in the stream and renewing it weekly. This was continued for 16 weeks.

(c) *General Results.* Examined after 8 weeks of this treatment, *Elodea canadensis, Potamogeton sp.* and *Lemna minor* were found to have disappeared but *Callitriche spp.* were vigorous. At the end of the 16 weeks of this treatment, the situation was essentially unchanged. The stream was then left untreated to see whether the delayed effect on Callitriche noticed after the first treatment in 1956 would occur again, but as this was not apparent up to the end of March treatment at the same rate was recommenced and carried on for another 8 weeks, but no change resulted, *Callitriche spp.* remaining alive, and *Elodea* and *Potamogeton* were still absent. As with the heavier dosage the treated portion of the stream was always much brighter and cleaner in appearance than the control in which dark slimy algal growths were generally present.

At the first assessment of the Spalding and Louth experiments (June, 1957) the only noticeable effect was the disappearance of the Algae and *Lemna.*

At the second (August, 1957) the absence of the species marked * was very striking as earlier they had been prominent. They had not reappeared up to the time of the last assessment which was several months after the end of treatment.

At the third inspection (October, 1957) the species marked + had disappeared.

At the last assessment (June, 1958) the only plants previously controlled which had re-appeared with the Algae and *Lemna minor* at Louth, having presumably floated down from the control. At Spalding the clinging submerged algae were absent both in the control and treated sections. At Spalding *Potamogeton berchtoldii* was not seen in 1957, but in June, 1958 it was very common in the control portion and stopped so abruptly at the treatment point that it has to be presumed to be susceptible to residual copper.

Water snails (mainly *Limnea stagnalis* and species of *Planorbis*) disappeared soon after the start of treatment and no living specimens were seen in October of the year of treatment as far as the outfall at Spalding and up to the 2 mile point at Louth. In the control portion of the dykes every handful of weed contained a noticeably large number.

No dead or sickly fish were ever seen, but fish were not much in evidence in either the control or treated parts of the dykes at Spalding and Louth and no attempt was made to assess the fish population. Fish of some size were seen in the treated dyke at Spalding in January, 1958 and small fish were common in the stream at Tickenham while under treatment at the lower rate (0.25 p.p.m. Cu).

" The effect on Algae was in all cases very striking . . . . "

Estimations of the copper in the weeds and in mud from the bottom of the dykes were made to see how much copper was taken up by plants and how much accumulated in the mud.

Samples taken at Tickenham 50 yards above the 1957/8 treatment point were from a part of the stream that had copper treatment in 1956.

Discussions and Conclusions

The table of susceptible and resistant species suggest that in general plants which are submerged or floating are susceptible while those which are emergent are resistant presumably because they are deep rooted. The only exceptions are the two species of *Callitriche*. This resistance of Callitriche is outstanding and of importance.

The susceptible weeds were generally destroyed quite early in the treatment and were still absent many months after treatment ceased. As they were affected at distances of at least 1 mile from the treatment points it appears that considerably less copper than 1 p.p.m. is necessary to control them. This is borne out by the results of the later Tickenham experiments in which 0.25 p.p.m. copper killed *Elodea canadensis* and other species.

The effect on Algae was in all cases very striking and of great interest to the Drainage Board's Engineers, but it is, of course, not a new observation.

Acknowledgments:

We gratefully acknowledge the co-operation of the Engineers to the Drainage Boards viz.: Mr. W. D. Miles of Spalding, and Mr. D. C. Morris of Louth without whose constant help this work would not have been possible. Dr. Wm. Plant's continued supervision of the Tickenham work is also acknowledged with thanks, as is also Mr. K. Wilson-Jones' helpful advice in all these trials.

Further, we wish to thank the British Sulphate of Copper Association for the provision of material and Messrs. McKechnie Brothers for laboratory facilities.

REFERENCES

1 Foster, H. S. and Plant, W. Proc. 3rd British Weed Control Conference 787-791.

(*Tables 1 and 2 on Page 116*)

OBSERVATION STUDIES ON TOTAL HERBICIDES.

By R. G. Hughes (*National Agricultural Advisory Service*) *South East Region.*

Introduction

Until recent years advisory work in connection with the use of non-selective herbicides was mainly confined to recommendations relating to the use of Sodium Chlorate and Sodium Arsenite. The fire hazard of the former coupled with the poisonous nature of the latter served as serious drawbacks to their widespread use on industrial, military or agricultural sites. During the last five years an increasing range of herbicides, suitable for non-selective weed control, has become available in this country. This influx of new chemicals has necessitated much field work to evaluate their efficiency, safety, persistence and other characteristics under a wide range of soil and climatic conditions and when applied to all types of vegetation found on various sites.

As a contribution to this work a number of preliminary observation study plots involving the use of Total Herbicides were laid down in the South East Region of the National Agricultural Advisory Service during 1956. These studies were designed to evaluate numerous herbicides recommended by commercial firms and to sieve the chemicals into two main groups based on persistency and speed of action. It soon became evident from these studies that for many sites, where a very mixed flora was encountered, a mixture of combination of herbicides would give the most satisfactory results and that annual or biennial retreatment with relatively low cost applications of herbicides would be required to maintain a weed-free area as desired on many sites. The observation study reported on here was commenced in 1957 to compare the effectiveness of various mixtures or combinations of herbicides alongside " straight " applications of total herbicides and during 1958 the testing of maintenance treatments has been in progress.

Methods of assessment

All the assessments carried out in this study have been based on visual estimations of the percentage ground cover of grass, weed and bare ground. They give an indication of vigour of growth of any one species but take no account of height of growth. These assessments were made at approximately three months' interval omitting the first three months post basic-treatment application, although observations on rapidity of effect were noted then. For the purpose of estimating the percentage ground cover each plot or half plot was divided into sections each of 1 yard x 2 yards. An average assessment was then obtained from the record for 10 sections in each full plot and 5 sections in each half plot.

ADVANCES IN TOTAL WEED CONTROL, WITH SPECIAL EMPHASIS ON NEW METHODS OF CHEMICAL EVALUATION.

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The initial treatment of established vegetation in total weed control places heavy demands on any single weedkiller. Mixtures of chemicals may be more effective but their evaluation requires special experimental techniques. The paper describes the principles of experimental evaluation of mixtures for total weed control.

Total eradication of weeds is now commonly practised on industrial sites in order to prevent damage to mechanical or electrical equipment, permit free drainage of water, eliminate fire and personal hazards, and improve the general appearance of the area. The initial eradication of weeds is of supreme importance, since once this has been achieved, total weedkillers can be used at much lower dosage rates and be sprayed

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on to weed-free areas to prevent a weed problem from ever appearing. This is of major importance when compared with mechanical methods of weed control, which can only be used once the problem has appeared and usually cause soil disturbance which actively ferments the germination of weed seeds. The evaluation of chemicals necessary to give total weed eradication can be a slow and laborious task, but new experimental techniques have recently been developed which give quick and reliable results.

Selective weed control places much less demands on weedkillers than total weed control, and this is almost entirely due to the assistance it receives from a strong crop. A checked weed in selective weed control is usually prevented from recovering and becoming vigorous by crop competition but in total weed control it would recover unhindered. The weed could now, due to the absence of competition, spread into areas of relatively bare ground and soon establish itself over a wide area. Thus although in total weed control a treatment might control 19 species out of 20 the remaining specie can become so vigorous that it leaves an impression of complete failure of the treatment. It is therefore extremely important that the initial eradication of weeds be as complete as possible, and this places very heavy demands on any single weedkiller.

Recent developments in selective weed control have led to the use of mixtures of chemicals to control a wider range of weeds. Mixtures such as dinoseb/MCPA, MCPB/MCPA, 2,3,6-TBA/MCPA and pentachlorphenol/aminotriazole give in many cases vastly superior results than either chemical alone, especially when used against mixed weed problems. A similar development in total weed control would also widen the range of weeds controlled and place less demands on any single chemical.

The use of mixtures would also have other beneficial effects in total weed control besides widening the range of weeds controlled. In many cases the speed of action would be increased considerably and the cost of treatment reduced. The initial treatment is generally required not only to kill all living weeds but also to prevent re-infestation by seedlings during the season following spraying. It is therefore a relatively persistent treatment and chemicals giving persistence are usually only slightly soluble in water. Such chemicals are largely taken into the plant through the roots and this makes them slow acting, especially against deep-rooted species, and in low rainfall areas it can be many weeks before lethal symptoms are apparent. This is always discouraging to the customer who often looses patience and assumes the chemical has not worked. A mixture of chemicals could speed up the rate of action especially if one chemical was effective through the foliage, and then symptoms would be apparent in a few weeks. This also helps in more certain control of many species since they are attacked in two different ways, through both the leaf and the root.

The most powerful chemical for total weed control which is commercially available is simazin (2-chloro-4,6-bis(ethylamino)-s-triazine). Simazin is exceptionally toxic to weed seedlings and has great persistency due to its very low solubility (3.5 p.p.m.). This enables it to remain in the upper layers of the soil for much greater periods than other weedkillers. It is taken up into the plant by the roots and thus seedling weeds are killed almost as soon as they have germinated. It is therefore the ideal weedkiller to maintain areas weed-free for long periods. When used on established perennial vegetation, however, simazin is slow in action, due to the slow movement of the chemical into the plant root zone, and occasionally very deep rooted species will not be completely controlled purely because the chemical does not reach their root zones in lethal quantities. It can thus be seen that a mixture of chemicals would be beneficial to simazin when it is applied on established vegetation, since it has been described how mixtures can widen the range of weeds controlled and also speed up the rate of action of persistent weedkillers.

Evaluation of mixtures in total weed control is an extremely difficult task, and it requires special experimental techniques. The optimum dosage rates of the component chemicals must be discovered in relation to types of vegetation, stages of growth, climatic conditions and soil types. The innumerable combinations of chemicals which would have to be tested would make evaluation from a knapsack sprayer a long and tedious task. The Chesterford logarithmic spraying machine has, however, proved invaluable in the evaluation of optimum dosage rates. The machine continuously dilutes a known concentration as the spraying proceeds, thus enabling a whole spectrum of concentrations to be covered in one operation. Any number of chemicals can be sprayed at decreasing rates, or, in the same operation, some chemicals can be sprayed at constant rates whilst others are sprayed at decreasing rates. A multiplicity of combinations of chemicals can therefore be quickly sprayed at decreasing rates to cover a wide dosage range. It also permits easy evaluation of different mixtures at equal costs over a wide price range.

Experiments have been carried out in 1958 with many chemicals as additives to simazin, and examples of some of these compounds include MCPA, 2,3,6-TBA, 2-4,D, 2-4-5,T, trichloracetic acid, sodium chlorate and many triazine compounds closely related to simazin. The chemicals used as additives were tested either singly or in groups, at logarithmically decreasing dosage rates with simazin at a constant rate. Markers were placed along the logarithmic plots at different price levels so that the variable effects of the treatments at these different costs could be easily studied throughout the season.

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The initial control of established vegetation is required to be as complete as possible since if the amount of vegetation present at the time of treatment has not been substantially reduced one year later, it can definitely be said that full benefit from the treatment has not been achieved. If, on the other hand, there was a substantial reduction, the subsequent treatment will have a less difficult task, and the dosage rate required will be automatically reduced. This, of course, will mean an accompanying reduction in cost. It is, therefore, well worthwhile that the initial treatment be made at the optimum time. The main disadvantage of the use of mixtures of chemicals with simazin is that the optimum time for application of each constituent in the mixture may be different, and the optimum time for the mixture itself therefore a compromise. Thus if application was made outside the optimum time one or more of the constituent chemicals might not prove effective.

The importance of the initial treatment in total weed control cannot be over-estimated, and this paper has tried to put forward a few of the problems which must be met. The success or failure of the methods described in overcoming these problems cannot, unfortunately, be fully evaluated until the forthcoming spring, and since it is always fatal to try to draw conclusions prematurely many questions must necessarily remain unanswered. The paper has tried to describe the methods of evaluation which were used in attempting to overcome the many problems, and it is hoped that most of them will eventually be resolved after the final evaluations of the trials have been made.

Amongst basic treatments applied in this study Simazin and Monuron/Borate combinations, particularly at the higher rates of application, have given the most satisfactory results in non-selective weed control. The application of these and other total herbicides at lower rates coupled with retreatment 12 months later has also given satisfactory results over an 18 months period. On some sites depending on type of vegetation present and the extent of growth the application of quick acting low persistency herbicides or mixture of herbicides followed at a later stage by low rate applications of more persistent total herbicides would give better results. Where translocated selective herbicides are used as an aid to treatment with total herbicides the activity of growth at the time of application will have considerable bearing on the efficiency of weed control.

The paramount fact emerging from a study of the efficiency of total herbicides is that mother nature abhors blank spaces. It is comparatively easy by means of a combination of basic treatments followed by maintenance treatments to produce a 90 per cent weed free area but there is always some resistant plant species eager, willing and able to recolonise bare ground. The flora of a site can be changed completely by the use of chemicals and on some sites a regrowth of grass in absence of dicotyledon weeds may be an advantage. In advisory work connected with the application of total herbicides each site demands an individual approach. The ultimate aim in terms of weed or grass control must be considered in relation to the flora present and in particular to the cost of attaining the desirable result following the use of various herbicides.

EXPERIMENTS on the CONTROL of AQUATIC WEEDS by means of COPPER SULPHATE.

(*continued from page 114*)

TABLE I.

The relative susceptibility of water weeds to copper sulphate.

	Spalding	Louth	Tickenham (1957/8 expt.)
Flowering Plants			
Potamogeton perfoliatus	S+	—	—
Potamogeton berchtoldii	S	—	—
Potamogeton densus	S	S*	—
Potamogeton pectinatus	—	S	—
Potamogeton crispus	—	S	S
Mryiophyllum spicatum	S+	S*	—
Lemna minor	S*	S	S
Elodea canadensis	—	S*	S
Alisma plantago-aquatica	R	—	—
Juncus articulatus	R	—	—
Sparganium sp.	—	R	—
Sparganium simplex	—	—	R
Callitriche obtusangula	R	—	—
Callitriche stagnalis	—	R	—
Callitriche intermedia	—	—	R
Phragmites communis	R	—	—
Glyceria fluitans	R	—	—
Hippuris vulgaris	R	—	—
Veronica anagallis-aquatica	—	—	R
Non-flowering plants			
Equisetum fluviatile	—	R	—
Algae			
Oedogonium sp.	S	—	—
Spyrogyra sp.	S	—	S
Enteromorpha intestinalis	—	S	—
Vaucheria sp.	—	S	—
Mougeotia sp.	—	—	S

KEY:

R = Resistant to the treatment applied to the site (*see experimental details*).

S = Susceptible to the treatment applied to the site (*see experimental details*).

TABLE II.

Copper Content of Plant and Mud Samples from the Three Sites.

Sample	Date Taken	Site	Distance from treat. Point in yds.	Cu. Content (dry matter) p.p.m.
Callitriche	14/6/57	Spalding	100	1750
,,	,,	,,	800	600
Mud	9/8/57	,,	70*	20
,,	,,	,,	40	180
,,	,,	,,	1090	95
,,	,,	,,	2070	95
Alisma	16/8/57	,,	50*	50
Hippuris	24/9/57	,,	2000	450
Potamogeton	,,	,,	2000	330
Alisma (leaves)	,,	,,	20	950
,, (stems)	,,	,,	20	1100
Callitriche	13/5/58	,,	800	65
,,	16/8/57	Louth	400	900
,,	24/9/57	,,	900	1100
,,	,,	,,	400	1500
,,	17/1/58	,,	1300	240
,,	13/5/58	,,	400	90
,,	8/10/58	Tickenham	200*	65
,,	,,	,,	50*	75
,,	,,	,,	200	125
Veronica	,,	,,	50*	60
,,	,,	,,	100	95
Mud	,,	,,	50*	50
,,	,,	,,	100	275
Callitriche	20/12/57	,,	300	700
Mud	,,	,,	300	120
Callitriche	31/1/58	,,	300	500
,,	9/5/58	,,	300	280
,,	,,	,,	200*	50

* Above treatment point, otherwise below.

Samples taken at Tickenham 50 yards above the 1957/8 treatment point were from a part of the stream that had copper treatment in 1956.